Summary
Steller Sea Lion Recovery Team Meeting
Marriott Hotel, Anchorage, Alaska
6-8 November 2002

Bob Small, Chair of the Steller Sea Lion Recovery Team (SSLRT or RT), opened the meeting at 08:40 on November 6. Minutes from the August meeting were reviewed and approved. The Chair confirmed that Robin Samuelson has withdrawn from the SSLRT, leaving the RT's total membership at 19. The RT agreed that a quorum for voting purposes will now consist of 14 members, and that once achieved a quorum will hold for the entire pre-announced meeting period even if some members must be absent for portions of that period. The number of votes necessary to pass any motion remains unchanged at 10.

In a review of old business, the Chair noted that the SSLRT had received a response to its letter to NMFS regarding the proposed reduction in NMFS funding for SSL research. The Assistant Administrator responded that NMFS was aware of the reduction and was working to restore funding levels to those of the previous year. The Chair will make copies of letter responses available to any RT members who wish to have them. There was little change in the status of SSL research permits; agencies have yet to receive new permits but expect to receive them within days. Revised drafts of the stepdown outline and Sections III, IV, V.A-B.1-10, and VI.A-B.1-9 were distributed in September and October; RT members asked that each future new draft be marked with the section number and draft date to assist record keeping.

<u>Update of Ongoing SSL Genetics Research</u>
John Bickham, Texas A&M University (TAMU)

Bickham reviewed the distribution of SSL and the extent of its population decline. The populations are currently defined by approximately 50 recognized rookeries and at this time samples for genetic analysis have been obtained from most. Rookeries have been grouped into regions primarily for sample size considerations. Previous research identified the existence of Eastern and Western Distinct Population Segments (DPS) based on a high degree of genetic differentiation on either side of 144°W longitude. Research published in 1998 suggested evidence for an Asian population that would divide the Western DPS into two distinct groups. Three ongoing projects at TAMU include population genetics analyses of mitochondrial DNA (mtDNA) control region sequences, cytochrome b analyses of BB-haplotype individuals, and nested clade analyses to look at population subdivision.

The first of these is a range-wide survey of genetic variation using mtDNA and nuclear gene markers in an attempt to identify and partition diversity into units that are useful for management. Researchers sequenced a 238 base pair (bp) segment from the control region of mtDNA from approximately 1,300 pups and 1,500 total animals representing 46 rookeries. Sample size by region ranges from 10 to 227, and researchers will work to increase sample size over time. A total of 135 mtDNA haplotypes have been identified. There is high haplotype diversity and distinct patterns of macrogeographic subdivision as shown by phylogenetic analyses of haplotype sequences and haplotype frequencies/distribution. Most haplotypes are relatively infrequent (1-2 individuals) and there are relatively few that are common to many individuals. This pattern suggests a population that has not gone through a severe population bottleneck (i.e., there has been no recent population crash to eliminate some haplotypes). In a review of haplotype patterns by region, some haplotypes appear to exhibit gene flow with their common occurrence in the center of the range and less frequent occurrence both east and west. Other haplotypes occur exclusively in either the Eastern or Western DPS. Two haplotypes (BB and A) appear to contradict gene flow by their presence throughout the range. Two potential hypotheses regarding this pattern are (a) these do not represent a single haplotype but a sequence derived through convergence in several areas, or (b) they are pleisiomorphic (ancestral) haplotypes that originated before the separation of the Eastern and Western DPS.

Geneticists estimate the genetic difference between groups using the statistic F_{ST}. Calculation of this statistic lends support to the 3-DPS hypothesis; there is a distinct break between the Eastern and Western DPS and the Asian populations are clustered within the Western DPS. These divisions are cleanest when animals are aggregated by region, probably because sample sizes at that level are larger. Researchers hope to increase sample sizes sufficiently to demonstrate a similar relationship when samples are grouped at the rookery level.

A variety of phylogenetic studies of mtDNA control region sequences support the theory that there are families of haplotypes that evolved in the Eastern DPS and have remained there. They appear to have originated from the widespread haplotypes A and BB (which do appear to be pleisiomorphic haplotypes) and lend evolutionary support for separation of the Eastern and Western DPS. The Asian population haplotypes also form clusters, but these are not as discrete as those for the Eastern and Western DPS. These data suggest that the break between the Eastern and Western DPS occurred longer ago and has been more complete than that between the Asian stocks and the remainder of the Western DPS. While the Kuril and Iony populations are distinct from central Western DPS stocks, the status of the Medney Island and Kozlova Cape stocks are less clear.

Cytochrome b analyses of BB haplotype individuals have involved the sequencing of a 1,140 bp segment for all individuals. Eight cytochrome b haplotypes have been identified, each with a distinct geographic distribution.

Nested clade analysis is a new technique developed by Templeton in the early 1990s to assess phylogeographic analyses. It is an analysis of phylogeographic patterns that employs phylogenetic, distributional, and frequency analyses and allows researchers to look at population distribution now and through time, showing areas of differentiation and suggesting hypotheses to explain why this differentiation might occur. The technique provides enhanced power over F statistics, allowing greater precision in gene flow estimates. TAMU researchers are using the technique to investigate cytochrome b patterns. The analytical process begins with 1-step groups to determine if there are statistically significant associations by geography. It then proceeds to 2-step and higher groups; it has not been possible to proceed beyond 2-step groups in this analysis.

RT questions and discussion:

- It is possible to estimate gene flow between the Western and Asian stocks, but those estimates currently have high levels of error. Researchers eventually hope to estimate the effective migration rates between all regions. Complete separation is unlikely and would only occur in populations that have been separated a long time. Based on the D-loop, there appears to be a fairly high degree of interchange, especially in the central part of the SSL range.

- Human exploitation would have effects on gene patterns that are similar to those of glaciations and other phenomenon, especially if a population was killed off and later recolonized.
- Rare haplotypes would be lost in a population that had experienced a bottleneck, and the population would not display the "L" shaped haplotype distribution pattern. SSL have not experienced any recent population declines that have been severe enough to alter that pattern. While there are some missing haplotypes, current sample sizes may simply be too low to detect them. Recognizing that rookeries are to some extent impermanent (i.e., animals may not die but instead move to other rookeries), the entire loss of rookeries or regions could affect genetic variability. The extent of haplotype loss in a bottleneck depends on how low the population goes and how long it lasts.
- RT members asked where the origin of the ancestral BB haplotype was located. Haplotype 3 appears to be the most pleisiomorphic and its distribution appears to be located in the central part of the range. It is currently speculative to identify that area as the origin.
- If other haplotypes were sequenced and were more diverse than BB it would suggest that particular haplotype is very old. Older haplotypes tend to display greater genetic diversity. Researchers currently expect to see diversity that is closely related.
- There could be selection for particular cytochrome b haplotypes, but selection for cytochrome b is difficult to prove and the issue is highly contentious among researchers. At this point researchers presume they are working with neutral genetic markers.
- Bickham believes that the separation of the Asian component is at the same level of certainty as separation of the Eastern and Western DPS. There are some rare haplotypes that are unique to the Kuril Islands populations. The line dividing the Asian component from the remainder of the Western DPS is unclear and would likely require additional sampling to resolve.

<u>Estimating Dispersal Between SSL Rookeries Using Molecular Data</u>
Greg O'Corry Crowe, National Marine Fisheries Service SWFSC

While the studies described by Bickham take an evolutionary perspective, this study takes a demographic perspective by considering how contemporary genetic patterns are influenced by dispersal. Researchers attempt to answer how the risk of extinction is affected by the connectedness among rookeries. Dispersal can increase risk if it acts to continually move animals into "bad" areas, but it can also reduce risk if it promotes recolonization of the range. Research examines how the patterns of variation in neutral genetic markers are influenced by gene flow (dispersal, inbreeding), genetic drift (influenced by population size), and by mutation. The genetic markers must be truly neutral to avoid the influence of selection. Over ecological time scales the effects of mutation are also likely to be small. Typical markers include microsatellites and mtDNA (maternally inherited), and both are highly variable. At this time the marker of choice is mtDNA, and researchers increase precision by increasing either the length of strand they examine or the sample size. The statistic F_{ST} is used as a measure of genetic differentiation; a value of "1" represents high differentiation and "0" represents no differentiation. They are currently working with a general model that simulates evolution of genetic differences among unequal-sized populations for different dispersal rates.

Early efforts have attempted to estimate dispersal between adjacent sites within the Western DPS (Akutan to Ugamak to Amak). To examine the precision of the model, researchers have also estimated dispersal between adjacent sites within the Eastern DPS where dispersal is expected to be high, and between sites in the Eastern and Western DPS where dispersal is expected to be low. Estimates of F_{ST} reflect expected patterns of dispersal in the Eastern DPS (Southeast Alaska), yielding very low F_{ST} values. In the Western DPS, values of F_{ST} between sites were higher than in the Eastern DPS, and comparisons between the Eastern and Western DPS yielded the highest F_{ST} values. Amak is an outlier in the Western DPS with its increasing abundance trend in recent years and plausible dispersal rates involving that site range between 0.1 and 1% per year. Plausible dispersal rates between Akutan and Ugamak are less than 0.01, which equates to less than 3 females per year. Between the Eastern and Western DPS the plausible dispersal rate is less than 0.001, which is less than one female per year.

Over 700 samples were collected for analysis last field season, and with the samples collected by TAMU there will be rookeries across the range that are represented by more than 70 samples. This will enable estimates of dispersal rates between the closest sampled rookeries, and those rates can be used in PVA models to assess risk.

<u>Population Viability Analysis (PVA) Analysis Update</u>
Arliss Winship, North Pacific Universities Marine Mammal Research Consortium

PVA estimates the probability that a species will go extinct or reach some critical threshold level within a specified period of time. That probability depends on (1) the population size and trend, (2) demographic stochasticity (i.e., chance), (3) environmental stochasticity, including catastrophes, (4) genetic diversity, and (5) management actions. PVA is generally restricted to quantitative modeling or similar studies. Previous PVAs for SSL have included York et al. (1996), Gerber and VanBlaricom (2001), and Ishinazaka (2002), and there have been a variety of other population modeling studies looking at historical trends.

The first step in a PVA involves developing a simulation model. This study uses a matrix population model consisting of females during the breeding season. A population is considered to comprise one or more rookeries. Basic parameters required include birth rate, survival rate (both juvenile and adult), dispersal rates between rookeries, and the number of animals on each rookery. Other important parameters that affect the risk of extinction include catastrophe or event parameters (requires estimates of start year, end year and magnitude stated as a proportional reduction) and density dependent parameters (requires estimates of maximum population growth rate and carrying capacity). Predicting future population dynamics is inherently uncertain, but all sources of uncertainty must be considered, quantified, and reported. There are good data for some SSL parameters (e.g., population trend), less data for others (e.g., dispersal rates), and no data for some (e.g., density dependence). Parameters are estimated using Bayesian statistics, which is a good method for dealing with uncertainty. The model is fit to the available data to estimate probability distributions for each of the parameter values, and this distribution of probabilities is used to estimate the probability of extinction.

To illustrate the process Winship used a PVA of SSL on Marmot Island. The data consisted of aerial survey and ground counts of pups during the breeding season. The model started with the population size in 1975, estimates of birth and survival rates, and no projected events or density dependence. It was also necessary to include several nuisance parameters to expand the data to estimate the numbers of non-pups in the entire population. In the first run, the estimated probability distribution for the necessary parameters encompassed the entire possible range for each parameter. The model calculated the likelihood of the data given that range of parameter values and output the posterior probability for each parameter (i.e., the probability that the true value fell into a particular bin in the parameter's probability range). This iterative process allows a narrowing of parameter estimates. The posterior probability of extinction (i.e., presence of less than 100 animals within 100 years) using this model was 100%. Since this simple model scenario allowed only exponential increase or decease, extinction was expected given the downward trend since 1975.

Winship illustrated three other scenarios that incorporated a variety of additional event assumptions that try to explain the existing data. The second scenario involved including a juvenile survival event that reduced survival rates to between 0.01 and 1.0. Given this scenario there was only a 2% probability that there would be more than 100 animals in 100 years. The third scenario involved both a juvenile survival event and a density dependent event that affected juvenile survival. The result of this scenario was a lower probability of extinction, with the estimate of the year in which the event ends being the key driving parameter. The longer after the present time the event ends, the less likely there will be recovery. The fourth scenario involved density dependence with a carrying capacity event. The probability of extinction was again lower, and the timing of the event's end was again key. At this stage Winship cannot determine which of these four scenarios is most probable.

There are several ways in which PVAs for multiple rookeries could be conducted. Researchers could perform a separate, independent PVA for each rookery, or the PVA could be performed for a group of rookeries with exchange rates. In the latter case, modelers must decide whether to assume identical vital (i.e., birth, death) rates among rookeries or to allow vital rates to vary between rookeries. Using identical rates is simpler, because the number of possibilities expands exponentially with variable rates.

Future work includes the addition of model features like demographic stochasticity and environmental stochasticity. Other data sources could be used for model fitting, such as medium format photography that would allow exploration of finer scales (e.g., large and small sizes within the pup category). Prior model parameters must still be finalized, and in this it is important for the RT to participate in the decision process. The model could also be made more mechanistic to explore what caused the events or what specific management actions might be.

Using Age Structures to Detect Impacts on Threatened Populations
Anne York, National Marine Fisheries Service NMML

The general progression of PVA involves constructing a model and then determining the probability that the population will reach a particular number of individuals within some number of years. Previous PVAs have modeled the female SSL population on three geographic scales (local, rookery, population) using a diffusion equation. The models have generally been an aggregate model of the Western DPS, or metapopulations consisting of clusters of rookeries. The effects of catastrophes on the population have also been examined. The median time to reach a population of less than ten individuals has ranged from 63 to 160 years using different models. Some authors argue that estimates of the probability of extinction are too variable to mean much without much more information than is commonly available. York preferred to describe another population model that could have implications for determining recovery.

This particular approach will be described in an upcoming article in the journal Conservation Biology by Eli Holmes and Anne York. It builds on York (1994) that calculated a life table for SSL using data from the 1970s and 1980s, and on York (1996) that showed constant rates of non-pup population decreases over three different time periods (mid-1970s to mid-1980s, mid-1980s to late-1980s, and late-1980s to 1994). Leslie matrix models were fitted to age structure and population size data to produce a measurement of demographic change. Data were restricted to the Central Gulf of Alaska time series of non-pup counts on rookeries and of pup counts on Marmot Island. They calculated an index of juveniles by measuring SSL from aerial photographs of haulouts that contained at least one adult male lying in a straight position. Dividing by the length of that male normalized the longest straight-line measurement of every animal in the photograph. Juvenile animals were generally 60 to 70% of the length of the longest male, so the index for a site consisted of the number of animals whose length was less than 50% divided by the total number of animals.

These data were used in an age-structured model that temporally varied survivorship and fecundity; starting values were estimated. The model employs maximum likelihood methods using iterative least squares. Four models were evaluated: (A) a single change occurring in 1983, (B) two changes occurred, in 1983 and 1988, (C) two changes occurred, in 1983 and 1993, and (D) three changes occurred, in 1983, 1988, and 1993. Model D provided the best fit to existing data, suggesting that declines in fecundity began in the early 1980s and continued into the late 1980s and 1990s. An Analysis of Variance was used to assign the decline to one of three factors based on the proportion of variance explained by the model. During the early 1980s, the model assigned 72% of the decline to low juvenile survival, 6% to fecundity, and 22% to adult survival. In the late-1980s to early-1990s the distribution shifted to 12% juvenile survival, 68% fecundity, and 20% adult survival. During the mid-1990s to late-1990s the assignment was 32% juvenile survival, 26% fecundity, and 42% adult survival. At some point it may be possible to use the joint distributions of survival and fecundity rate reductions to estimate extinction probabilities.

Steller Sea Lion PVA Modeling Process
Dan Goodman, Montana State University

PVA is a probabilistic population projection that reports the fraction of trajectories that go extinct within a designated time horizon. The particular model Goodman proposes to develop for the SSLRT will be age structured; spatially, seasonally, and management explicit; include environmental and demographic stochasticity; provide for parameter uncertainty; and produce probabilistic output (i.e., a probability distribution that describes the persistence time of the population). The model is a form of risk analysis, and uncertainty is a part of that risk. The model can be used as the basis for making listing decisions (up or down), assisting in the specification of delisting criteria and the preparation of Biological Opinions, judging the adequacy of the Recovery Plan (RP), setting priorities for research planning, and arguing for adaptive management.

A variety of NMFS documents provide the standards for listing categories. Endangered status is represented by a probability of less than 99% that the species will persist for more than 100 years. Threatened status is represented by a probability of greater than 10% that the species will be endangered within 20 years. Endangered status is not affected by the life cycle of the species; 1% in 100 years is merely a statement of the acceptable error rate. Threatened status is more complicated, and is affected by both the volatility of population numbers and by the speed with which the agency can respond. In a quest for consistent standards, delisting criteria should be objective and measurable conditions which assure that a species is not Endangered when its probability of persisting more than 100 years is greater than 99% and is not Threatened when its probability of becoming Endangered in less than 20 years is less than 10%.

To use the model to judge the adequacy of the RP, the RT could determine that an adequate RP is a plan of actions, with contingencies, that assures in advance that the probability of recovery in less than 100 years is greater than 95%. Research could be prioritized based on its potential to reduce the probability that persistence time will be less than 100 years. Research can contribute to this process either by reducing the uncertainty regarding outcomes or by reducing the uncertainty regarding management choices. The model could assist in adaptive management if research planning is among the contingencies in a recovery plan; the model could be used to help minimize cost while controlling risk.

The model reflects that which is known. For that reason the model can be used to evaluate management scenarios, but not to evaluate the effects of management scenarios or regime shift hypotheses. Those effects are not things that can be chosen. Similarly, the model cannot be used to evaluate hypotheses that are on the table, since in order to use the model probabilities must be assigned in advance; hypotheses with no probability cannot be evaluated. To do its work the RT needs two models; one model should be used in a retrospective analysis to estimate parameters and quantify the uncertainty while the other should be a PVA that is used in a predictive capacity. The same model could be used for both purposes by simply running the retrospective model forward, but they need not be the same models. The RT cannot control the number of models developed by researchers but it can control the quality and transparency of those that it uses.

Key model inputs include a basic set of life tables, quantifiable migration rates, an understanding of seasonal movement patterns, parameters in the food web model, the effects of regime shift on the ecosystem and on SSL, the frequency of regime distribution, density dependence, and the effects of management to include fisheries management (actual information rather than imaginary scenarios). These data are key because the recovery criteria include such long time horizons. Model inputs need to consider the availability of data, any plans to collect unavailable data, statistical inference parameters and the adequacy of the team developing them, and consensus on default distributions to include the plausible range of possibilities.

Goodman encouraged the RT to recommend that the agencies involved provide the institutional approaches necessary to produce these inputs. These include a consensus data set, which may require some form of data inventory committee to reach consensus on data usability and make it available to all on the Internet. The RT should become involved in coordination with research planners and with the statistical analyses. These analyses should also be documented and made available on the Internet; the RT should maintain the same transparency with statistical analyses as it does with data. There must also be consensus on default distributions, possibly though a committee of experts that would document these statistics and make them publicly available.

RT questions and discussion:

- Goodman acknowledged that the process he envisions is ambitious and that it may take longer than the RT's current 3-year timeline to accomplish. He questioned whether a proper measure of success for the ESA is in the number of delistings or in the number of extinctions prevented. Most of what he described can be accomplished in two to five years, but data events based on lengthy processes will take longer to document. The RT will need to work with what it has now, and flag tentative data for replacement with real data when they become available. Goodman could not provide examples of other RTs that have used a similar approach and described the situation as "evolving". The computing power needed to perform these analyses has only recently become available, and several RTs now find themselves in a similar situation. This RT will need to evaluate the full PVA approach and determine how far down that path it can afford to go, recognizing existing time limitations.
- Many of the data needs are driven by the 100-year timeline. Shortening that timeline would make the analysis easier, but the 100-year perspective is probably correct if the ESA is to be viewed as legislation for posterity. Managers can be misled if they manage for transient effects that look good in the short run but have no long-term durability.
- The model can be useful even if there are disagreements over habitat impacts or the effects of fisheries. Under the ESA burden of proof on precautionary short-term decisions, the more information managers have the less precautionary they can afford to be. Margins of safety can be replaced with margins of knowledge.
- There is no legal requirement for the RT to use a PVA approach, but there are strong logical arguments in favor. Within the profession there is a growing consensus that PVA is the proper approach. The alternative to PVA is common sense, but that can often fail when RTs are trying to achieve consistent standards or are trying to defend their recommendations in court. PVA is generally only one of several available tools but it is usually one of the most defensible.

- Phobias about models are well founded only if the model in question is a "black box." The RT must delve into the models it uses to determine why they may give different results, especially if any model gives results that do not conform to common sense. The RT will need standards for how it will resolve ambiguities and needs to question unwarranted assumptions. Assumptions should be represented as probability distributions rather than as point estimates.

Recovery Plan Revision – Review of Progress and Process

Small reviewed progress since the August meeting, which included distribution of a proposed timeline in August, draft sections III, V.A-B1-9, and VI.A-B1-9 in September, and sections IV, V.B.8, and V.B.10 in October. The stepdown outline has been revised and distributed, but none of the narrative drafting assignments from the last meeting has been completed. Following the August meeting, several RT members requested a review of the data on the most crucial factors affecting SSL. Small responded to this request by requesting the review of nutritional stress data that will be presented by Fritz later in this meeting. Small asked the RT to evaluate whether this approach was useful.

Capron reviewed the RP process and relayed information he had obtained in a recent training session. To date the RT has developed a basic outline structure for the RP, prepared a draft background section and stepdown outline, and begun the PVA process. In developing listing criteria and tasks, it important for the RT to link those criteria and tasks directly to the threats and their removal (Handout, p. 27). Capron speculated that increased legal requirements would likely make the criteria originally used to list SSL unacceptable today. Today RTs need to make explicit linkages between threats, ESA listing factors, and tasks (Handout, p. 6). Using the RP for Florida manatees as a case study, he showed that recovery criteria in the original draft rejected by the courts were vague (Handout, p. 41ff) and those in the current revised draft have been linked to each listing factor and threat (Handout, p. 47ff). Another example he cited was the USFWS listing of the snail darter; the courts prohibited the agency from delisting the species without a RP that addressed ESA listing factors and threats, even though the agency had received new information indicating that the snail darter should never have been listed.

NMFS hopes that the SSLRT will provide a clear articulation of the threats to SSL. Without this clear statement, Capron feared that the listing criteria and tasks may be without justification. He suggested that the RT could do this by completing a formal Threats Assessment such as that described in the Handout, p.1ff. This process requires the RT to clearly define and agree on threats, severity, immediacy, likelihood, and restoration feasibility. The document can then be used to provide parameters for models, and justification for criteria and tasks, PVA could be used as a reference to extinction on its own or to test demographic criteria that the team develops. In Capron's view, it is currently premature to discuss tasks in the context of the stepdown outline because there has been no clear evaluation of the threats. The task list must flow from the threats. He believes that the RT currently faces three major decision points: (1) how does the RT assess threats, (2) how does the RT intend to use PVAs, and (3) how does the RT plan to deal with the potential for a third (Asian) DPS.

RT questions and discussion:
The RT engaged in an extended discussion of Capron's third decision point. Some RT members maintained that the RP should be written with two DPS, but that the western boundary of the Western DPS should be the international border. They noted that all Western DPS data used in PVAs come only from the US side of the border, and that the ESA had no force against non-federal (US) actions. Opponents to this approach feared that SSL from the US side could move across the international border into areas of greater risk (e.g., from the Western Aleutians). Other RT members thought that since the Western DPS is currently classified as Endangered, completion of a RP for that DPS as currently constituted held highest priority. If NMFS decides to split the Western DPS into Central and Asian components, however, there is risk that the RP would rapidly become outdated if its criteria and tasks are no longer applicable. Alternatively, the RP could recognize the Asian stock as a subcomponent of the Western DPS from the beginning. The restoration feasibility for threats to that component may be low and it may not be possible to address those threats directly, but it may be possible to use PVA to evaluate other actions that could be taken to compensate. Proponents cited the current status of the Eastern DPS within Canadian waters as an example of such treatment. Still other RT members suggested that completion of a RP for the Eastern DPS might be a productive use of time while stock status in the Western DPS is clarified. They noted that the Eastern DPS cannot currently be delisted because there are no delisting criteria. Opponents to this approach saw no urgency to rush toward a delisting of the Eastern DPS.

The RT agreed to recommend that NMFS begin a review of the available genetic data to assess the status of the Central and Asian SSL stocks within the Western DPS. NMFS staff cautioned that the review could take at least a year, and that genetic isolation does not automatically lead to the designation of a separate DPS. In the interim, the RT will continue its work on the Eastern and Western DPS concurrently. Several members noted that the threats facing the Eastern and Western DPS are similar, and that to understand the decline in the Western DPS it is first necessary to understand why the Eastern DPS is not responding in a similar fashion.

Steller Seal Lion Prey Fields and Climate Change – A Review of the Data
Lowell Fritz, National Marine Fisheries Service

Negative impacts of environmental change could be the result of decreased production, altered patch distribution, or changes to the structure or distribution of biological communities. Regardless of the cause, the negative outcome is either nutritional stress or direct mortality through increased predation. SSL reproductive success or survival could have been reduced in the 1980s and 1990s due to nutritional stress related to increased consumption of gadids and decreased consumption of pelagic forage fish, and these changes in SSL food habits could have been due to changes in fish distribution and/or community structure resulting from climate changes in the North Pacific during the late 1970s. If this hypothesis is true, then it follows that (1) pollock and other gadids were at relatively low levels prior to recruitment events in the late 1970's and have been at relatively high levels since; (2) capelin, herring, and other forage fish were at high levels prior to the late 1970s and have been at relatively low levels since; (3) SSL did not eat much gadid before the late 1970s; and (4) gadids are lower quality prey than pelagic forage fish. This presentation seeks to determine whether the available data support these implications.

The data available to examine these implications consist of groundfish and herring stock assessments; groundfish surveys and fishery information; food habits of groundfish, SSL, and other pinnipeds; and proximate analyses of fish. The major indices of climatic change include the El Nino-Southern Oscillation (ENSO), the Pacific Decadal Oscillation (PDO), the Aleutian Low Pressure Index (ALPI), and the North Pacific Index (NPI). Three recent regimes have been recognized, with the period prior to 1977 (Regime 1) characterized as relatively cool, and the period from 1977 to 1989 (Regime 2) characterized as relatively warm. The pattern of Regime 3 (1989 to present) is currently unclear.

Important stocks in the Eastern Bering Sea (EBS) consist of pollock, Pacific cod, herring, and flatfish. Foreign fleets took the largest catches of pollock in the EBS prior to 1976. The INPFC reduced harvest levels of pollock in the mid-1970s due to evidence of stock weakness. Pollock biomass in the EBS tend to show cycles of abundance following years of good recruitment; it appears that the biomass peaked at levels in excess of 12 million mt in both 1971 and 1985. Pollock recruitment during Regime 2 is characterized by higher variability than in preceding or succeeding periods, but the chances of an above average year class are about the same under all three regimes (range = 50% to 62%). Indices like the ALPI appear to have little predictive value for large pollock year classes. Survey data suggest that Pacific cod biomass in the EBS was high in the mid-1960s, declined and remained low during the 1970s, and then increased in the early 1980s following strong year classes that spawned in 1977 and 1982. The frequency of above average year classes is unknown during Regime 1, 58% in Regime 2, and 44% in Regime 3. The history of herring catches in the EBS varies as the fishery has transitioned between areas and from a reduction to a sac roe fishery. Herring biomass was at very high abundance during the 1960s (Regime 1), low abundance though the 1970s, and higher abundance in the 1980s. Even at its peak in Regime 1, the 1.2 million mt herring biomass was only a small fraction of the pollock biomass. Examination of EBS flatfish (rock sole, yellowfin sole, halibut, and arrowtooth flounder) year classes suggests that large year classes occurred during one or more of the three regimes. Historic records suggest that pollock, cod, Atka mackerel, arrowtooth flounder, Greenland turbot, and Pacific halibut were all common in the Bering Sea at the turn of the century.

In the Gulf of Alaska (GOA) important stocks include pollock, Pacific cod, Atka mackerel, herring, and flatfish. NMFS surveys of GOA pollock in 1973-75 suggest that pollock was the dominant species in the bottomfish community and increased considerably relative to 1961-63. The spawning biomass of pollock in Shelikof Strait declined by 90% during Regime 2; trends from the most recent stock surveys suggest that the stock increased in the 1970s, declined slightly, and then increased in the late 1970s to peak in 1982. Since 1982 the stock has experienced steady decline. The frequency of large pollock year classes has decreased steadily, from 71% in Regime 1 to 8% in Regime 3. GOA Pacific cod biomass increased in the early 1980s following strong year classes spawned in the late 1970s and early 1980s. The frequency of strong year classes has declined from 50% in Regime 1 to 20% in Regime 3. GOA Atka mackerel harvests averaged 20 thousand mt per year during 1974-78, but the fishery moved west from Kodiak in the late 1970s to early 1980s; there was no GOA fishery and the species was not collected in surveys during the 1980s and 1990s. A small fishery began in the western GOA during the early 1990s and the species is currently at low abundance levels in the GOA. GOA herring stocks show strong synchrony of strong year classes in all areas. Strong year classes occur approximately every five years and appear to correspond to warmer water conditions. Strong year classes for GOA flatfish (Pacific halibut and arrowtooth flounder) occurred during all three regimes.

Evidence for a regime shift in the GOA during the late 1970s comes primarily from shrimp trawl survey data (Piatt and Anderson), but this pattern does not seem to agree with those observed in other shellfish fisheries. King crab catches peaked in 1966 followed by decline, and declines followed the fishery from king crab to tanner crab. There is also some evidence for serial depletions of shrimp populations before 1977. Fritz maintained that shrimp surveys represent sampling confined to selected bays (where they anticipated high shrimp catches) using gear designed to catch shrimp and that the species composition suggested by these samples does not reflect NMFS abundance survey distribution in all years. The shrimp trawl data that appear to show distributional shifts are presented as proportion of catch and are neither a biomass estimate nor a survey of the GOA community. What appear to be changes in abundance may actually be redistributions of the species in response to water temperatures.

Food habits of SSL in the Western DPS have been examined using stomach samples prior to the 1990s and scat samples since that time. In all periods, pollock are ranked highly in frequency of occurrence, and in several periods cod was also frequently observed. Consumption of gadids is also fairly common in the Eastern DPS regardless of time. Fur seal investigations at the turn of the century suggested that pollock was the most important part of the seal's diet, along with cod, halibut, and Atka mackerel. Studies throughout the 20th century suggested that gadids, capelin, and squid were all common prey items.

The energy content of common SSL prey species varies widely, with ranges in caloric density for many gadids overlapping those of osmerids. Seasonal variation in the lipid content of fishes can be extremely significant. Proximate composition and caloric density varies with age, size, and sex of fish, as well as with seasonal, environmental and nutritional influences.

Fritz's conclusions from these data are as follows: (1) Gadid populations fluctuate. Fritz believes there is strong evidence that gadid populations have previously been at levels similar to those seen after the 1970s. (2) Little is known about forage fish abundance other than herring, and herring increased in the 1980s. Even when herring abundance was at its peak it represented only a small fraction of the pollock biomass. (3) Gadids have consistently been a prominent part of fur seal and sea lion diets, and gadids are a prominent part of otariid diets worldwide. (4) The caloric content of prey items varies seasonally, and prey value is a function of caloric content and the cost of obtaining it. SSL in the Eastern DPS eat large quantities of pollock and are increasing at a rate of 2% per year.

RT questions and discussion:

- The RT had extended discussions on the utility of the approach taken in the presentation by Fritz. Several RT members liked the approach, which looked at the implications of a hypothesis. Some suggested that a more structured approach might be useful; the RT could list specific questions that should be addressed. Others noted that Fritz's presentation dealt only with prey fields, and that there were several gaps in the consideration of nutritional stress that should also be addressed. They suggested forming a workgroup for this purpose to ensure a balanced presentation. Others preferred to go directly into a threats assessment, believing that another summary of food habits data would be unproductive.

- Fritz acknowledged that his presentation was a reaction to the strong implications contained in current drafts of the background section suggesting that the environment in the North Pacific changed in the 1970s and this caused the decline in SSL. Fritz and others disagree, maintaining that those conditions were not aberrant or outside the range of conditions that SSL had experienced at other times.
- Some RT members questioned whether the shrimp trawl data or the NMFS survey data are a more accurate representation of the prey available to SSL. Shrimp trawls may better represent the nearshore environment, but it is difficult to determine the significance for predators. The presence of a biomass in a region does not necessarily mean that it is available to predators.

Recovery Plan Revision – Review of Revised Background Sections

The RT began a review of the revised Sections V.B.7 and V.B.8 (see Appendix), but reassessed this process amid concerns over the quantity and characterizations of literature citations. Several RT members maintained that the background sections should not be a comprehensive dissertation of every reference pertaining to the identified threats to SSL, but a more limited sketch to characterize the nature of those threats. They suggested that selected experts could be asked to perform interim reviews as the document evolves to evaluate their completeness. Other RT members were concerned that the current draft appeared to present as fact some concepts that might not be supported by available data (e.g., significant changes in the historic composition of fish populations resulting from environmental regime shifts) and that additional critical review of these assertions was necessary. The RT expanded this discussion to consider the purpose of the background section in the current RP revision. There was general agreement that there will probably never be sufficient information to conclusively explain the historic decline of SSL populations. Several members stated that the RT should focus on current conditions, and review history only to the extent necessary to understand the present (e.g., the regime shift of the 1970s may have affected SSL survival, but it is unlikely that SSL face those same conditions now). They saw no need at this time to either agree upon or judge the past, preferring to place more emphasis on identifying and addressing current and potential threats. Others saw value in understanding the past as a guide to future actions, and did not discount the possibility that past conditions could reoccur.

Proponents of a more current focus appeared to be in the majority, so the Chair asked RT members to revisit the most recent drafts of Sections III, V.A-B.1-9, and VI.A-B.1-9 (distributed in mid-September and mid-October) to ensure that the presentations are brief but balanced and comprehensive summaries of current threats. Disputed data should be acknowledged, and all assessments or evaluations of the identified threats should be deferred to Sections V.B.10 and

VI.B.10. Although the Asian component may be split from the Western DPS in the future, Section V.B should still include threats to that Asian component. RT members were asked to provide specific constructive comments to Loughlin by Friday, December 13. These comments should recommend specific language rather than simply suggest general direction. The recommended text should be provided with no formatting and with complete citations for new references. Loughlin will incorporate those suggestions by December 25, and another revision will be distributed to the RT for review.

In light of the earlier presentation by Capron, Pitcher and Loughlin agreed to revise the current draft of Section V.B.10 to include a draft threats assessment table. They propose to use an approach similar to that of Loughlin and York (2000)[1] to evaluate the extent to which the identified threats can account for the numbers of animals currently missing from a declining population. They expect that a revised draft will be available for distribution to the RT by December 25.

Capron and Parker reviewed revisions made to Section IV. The most recent revision attempted to expand the scope of the original draft, and included brief descriptions of other MSFCMA closures in addition to actions taken under the MMPA and ESA. A concluding paragraph was added to the listing of actions to highlight the scientific uncertainty surrounding the efficacy of closures. RT members were concerned that the current draft provides little information that could be used to evaluate the effectiveness of current management measures. Members were interested in the rationale behind particular actions, and whether those actions had their intended effect. They recognized that it might be difficult to directly relate fishery management actions to SSL population levels, but they believed it should be possible to identify other more immediate consequences (e.g., change in fishing practices, reductions of interactions and/or shootings, reductions of catch in Critical Habitat, etc.). Other members also suggested that the current concluding paragraph might be more appropriate as an introductory paragraph. Capron agreed to change this section from a chronological listing of management actions to a summary of fishery management tools that have been used to address the threats to SSL. He will discuss the effectiveness of those measures to the extent possible. RT members were invited to comment on the current draft if they believe other types of conservation measures have been omitted, but to otherwise expect substantial changes in the next revision. Capron expects to have the next draft available by Friday, January 31, 2003; RT members will be asked to provide comments on the second revised draft at the next meeting.

The RT discussed several options for informational workshops, including an expansion of the earlier presentation by Fritz. Pitcher and Loughlin were asked to anticipate which threats would be most contentious and require additional RT discussion; predation and fisheries were mentioned as the leading candidates. Small agreed to schedule several experts on predation to make presentations at the next RT meeting to address the current potential threat of predation on the Eastern and Western DPS. Presenters will be asked to describe the types and numbers of predators, the numbers and cohorts of their prey, and where and when that predation would

[1] Loughlin, T.R. and A.E. York. 2000. An Accounting of the Sources of Steller Sea Lion, *Eumetopias jubatus*, Mortality. Marine Fisheries Review. 62(4)40-45.
Available at: http://spo.nwr.noaa.gov/mcontent.htm

likely occur. They will also be asked to explore evidence that both supports and discounts the potential for predation effects. RT members suggested several potential presenters.

RT members discussed topics that could be addressed in a workshop on fisheries impacts. They recognized that the threats posed by fisheries are multidimensional, including disturbance, localized depletion, management assumptions regarding surplus production, and others. Many members believed that signs of nutritional stress in SSL populations would be the most likely evidence of fishery impacts, and that the RT should first determine whether there is currently evidence of such stress. They suggested that a working definition of nutritional stress could be: a physiological or behavioral state resulting from sub-optimal quantity or quality of available food resulting in reduced fitness. Since discussions of the related topics are expected to be lengthy and the predation discussions were already scheduled for the next meeting, the RT agreed that presentations on fisheries and nutritional stress should be held at a later time.

SSLRT Meeting Schedule

The next meeting of the SSLRT was scheduled for February 11-13, 2003 in Seattle. The Chair indicated an early start on the 11thand a mid-day stop on the 13th. Items tentatively scheduled for the agenda include a report from the Recovery Criteria subgroup, a discussion of the anticipated NRC report, a PVA modeling status report from D. Goodman, and the invited reports on predation threats. Members were also reminded that the annual review of SSL research has been scheduled for January 13-17, 2003. The agenda for that meeting was not yet final, but several reports on new predation and nutrition research are expected.

The meeting ended at approximately 13:00 on November 8.

Table 1. Attendance at the meeting of the Steller Sea Lion Recovery Team held November 6-8, 2002 at the Marriott Hotel, Anchorage, Alaska.

	Robyn Angliss	National Marine Fisheries Service
*	Shannon Atkinson	Alaska Sea Life Center
*	Linda Behnken	Alaska Longline Fishermen's Association
	John Bickham	Texas A&M University
~	Vernon Byrd	U.S. Fish & Wildlife Service
~	Don Calkins	Alaska Sea Life Center
	Shane Capron	National Marine Fisheries Service, OPR
†	Al Didier	Pacific States Marine Fisheries Commission
*	Doug Eggers	Alaska Department of Fish and Game
*	Dave Fraser	F/V Muir Milach
*	Lowell Fritz	National Marine Fisheries Service
*	Tom Gelatt	Alaska Department of Fish and Game
	Dan Goodman	Montana State University
*	Dave Hanson	Pacific States Marine Fisheries Commission
*	Lianna Jack	Alaska Sea Otter and Steller Sea Lion Commission
*	Tom Loughlin	National Marine Fisheries Service
	Lloyd Lowry	US Marine Mammal Commission
	Sue Moore	National Marine Fisheries Service NMML
	Greg O'Corry Crowe	National Marine Fisheries Service SWFSC
*	Donna Parker	F/V Arctic Storm
	Mike Payne	National Marine Fisheries Service
*	Ken Pitcher	Alaska Department of Fish and Game
**	Bob Small	Alaska Department of Fish and Game
*	Alan Springer	University of Alaska, Fairbanks
	Beth Stewart	Aleutians East Borough
*	Ken Stump	
	Ward Testa	National Marine Fisheries Service NMML
*	Andrew Trites	University of British Columbia & North Pacific Universities Marine Mammal Research Consortium
~	Terrie Williams	University of California, Santa Cruz
	Arliss Winship	North Pacific Universities Marine Mammal Research Consortium
*	Kate Wynne	University of Alaska, Kodiak
	Anne York	National Marine Fisheries Service

* Steller Sea Lion Recovery Team Member
~ Steller Sea Lion Recovery Team Member, absent
** Chair, Steller Sea Lion Recovery Team
† Rapporteur

STELLER SEA LION RECOVERY TEAM

Draft Agenda
6-8 November 2002
Marriott Hotel, Kenai/Denali Rooms
Anchorage, Alaska

Wednesday, 6 November

8:30 am
1. Review and approval of agenda
2. Housekeeping: Quorum dynamics, other?

9:00 am
3. SSL genetics research
    - John Bickham, Texas A&M
    - Greg O'Corry-Crowe, NMFS

12:00 pm – Lunch Break

1:00 pm
4. Population Viability Analyses
    - Progress and preliminary results
    - Further model development and input needed from Recovery Team

Thursday, 7 November

8:30 am
5. Recovery Plan Revision
    - Progress to date, review recovery process
    - Discussion of factors influencing SSL populations: Nutritional Stress caused by environmental change
        i. Presentation of scientific evidence and main assumptions – L. Fritz
        ii. Discussion – Strength of evidence

12:00 pm – Lunch Break

1:00 pm
6. Recovery Plan Revision continued
    - Review of revised background sections

Friday, 8 November

8:30 am
7. Recovery Plan Revision – continued

- Review of revised background sections
- Development of Recovery Strategy section

12:00 pm – Lunch Break

1:00 pm

8. Recovery Plan Revision – continued
    - Review progress on Stepdown outline and Narrative
    - Further development of Narrative
    - Other?

3:30 pm

9. Determine major topics for February meeting, (e.g., research reviews, recovery plan, etc.); adjourn

Appendix

The following section lists RT comments on the drafts discussed on November 7. Page and paragraph (¶) numbering refer to those drafts, which had been distributed in September and October. Paragraphs are numbered as complete paragraphs from the top of the page; information in incomplete paragraphs at the top of a page is designated as following (ff) from the last paragraph of the preceding page. The name(s) of the RT member(s) or others who may provide written alternatives are shown in brackets [] following many of the comments.

Section V.B.7 Comments

- It is important to understand the significance of PDO and other long term weather averages. The linkages to fish populations are often not direct. Interannual variability is often equally as important as the averages.[Stump]
- Regime shifts are a well-accepted phenomenon, and there are approximately 8 different indices that have been discussed in the literature. It is important to understand that regime shifts do not necessarily constitute a simple reversal to the conditions of the previous regime. References to "cycles" should probably be replaced with references to "changes". A broader overview of the factors relevant to SSL will be provided. [Trites]
- P20 ¶1 – This section indicates that there was a decrease in the abundance of capelin and an increase in the abundance of pollock. There are no data on capelin abundance and the pollock data we have suggest that changes in abundance were not that significant. The text does not appear to be consistent with the data we have.
- P20 ¶2 – Several of the cited references deal with changes that occurred in other areas (e.g., Vancouver Island, eastern Gulf of Alaska) and not in the area of the Western DPS. Some RT members were unaware of any actual observations of similar changes in the subject area and suggested any assertions that conditions were the same in all areas represent an hypothesis. [Stump]
- P20 ¶3 – This paragraph implies there are several sources for this information and cites only a single reference.
- P21 last ¶ - Some RT members questioned why populations of California sea lions and harbor seals were unaffected if changes in production were so significant. Others cited the peculiarities of the California oceanic domain, disassociation between events in the continental shelf and inshore waters habitats, and unique situations that could occur when a population is far below its carrying capacity. [Stump]

Section V.B.8 Comments

- P1 ¶3ff – This paragraph begins with "Considerable evidence suggests…" but only cites one set of birth rates. It should probably start "Birth rates suggest…". The second sentence which starts "Indications of disease…" is incorrect; the data are insufficient to support either assertion regarding disease. References to nutritional stress in the "1970s and 1980s" should be more specific, since the last sample was collected in 1986. It is also important to consider the seasonal component of this sampling (i.e., collection during the summer only). Failures to detect changes in size or mass may be due to the fact that sampling protocols were changed in the 1970s and the necessary data were not collected. This section focuses only on reproduction and does not include concepts like foraging strategies, foraging energetic rates, and metabolic rates. [Pitcher, Stump, Trites]

- P3 ¶1 – No mechanism for changes in prey availability are suggested. Change "probable" to "possible".
- P3 ¶2 – Clarify that Brodeur and Ware (1992) considered only the Gulf of Alaska and there are no comparable data for the Bering Sea. Circumstantial evidence from fisheries shows that other stocks were abundant during that time so an ecosystem crash is unlikely.
- P3 ¶3 – The assertions of Alverson (1992) regarding changes in ecosystem structures appear to be different than those suggested by Fritz in his presentation. The existence and sources of data that both support and contradict these assertions should be noted. Other RT members suggested that Alverson did not suggest that pollock were poison, merely that SSL were not getting enough of whatever it is that pollock do not contain.
- P3 ¶4 – The first sentence characterizing the fat content of pollock should be qualified seasonally, and there are no citations to support these assertions. Real data should be cited. Some RT members questioned why only a single study was cited, and emphasized that it was important to consider vitamins, ash, and other nutritional factors and not just calories. They noted that some segments of the Eastern DPS consume quantities of gadids comparable to those of the Western DPS with no apparent negative effect. [Atkinson, Fritz, Stump, Trites]
- P4 ¶4 – This paragraph (discussing changes in predation) is inappropriate in this section and should be moved either to Section V.B.2 (Predation) or V.B.7 (Climate Change).